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Full Length Research

Determinants and challenges of applying sustainable agriculture practices among rice farmers in Mwea, Kirinyaga County, Kenya

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For a development project to be planned and implemented in any area it is essential that adequate information about the area is gathered for the success of the project to be feasible. Mwea Irrigation scheme is the largest in Kenya but rice yields have been declining over the years. One of the factors to sustained production is adopting sustainable agricultural practices. The objective of this research was to determine the influence of farmers' socioeconomic characteristics on application of sustainable agriculture practices (SAPs) in rice farming in Mwea and the challenges the farmers face in applying SAPs. Cross sectional design, proportionate stratified sampling technique and questionnaire were used to select and collect data from 144 rice farmers. Statistical tools such as frequencies, percentages, means, standard deviation and appropriate correlation coefficients were generated to describe or identify relationship among variables of the study. Results revealed that majority of rice farmers in Mwea are youthful males. Application of SAPs is influenced by a farmers' knowledge level, educational attainment, membership to an organization, contact with extension and the size of land they have under rice. There are many challenges hindering farmers to adopt SAPs in Mwea. This study recommends trainings for farmers on SAPs and a policy to encourage the youth to remain interested in agricultural projects.

Key Words: Sustainable agriculture practices, rice farming, livelihoods, youth.

INTRODUCTION

Rice is the staple food for more than 50% of the world's population and its potential role in alleviating food insecurity problem was recognized by the United Nations General Assembly at its 57th session by declaring the year 2004 the International Year of Rice (FAO, 2006) and this saw an increase in production in subsequent years. However, In Sub-Saharan Africa, production continues to be outpaced by consumption, and therefore, the continent spends about 1 billion US Dollars annually on rice imports (Donkoh and Awuni, 2011). Sustainable

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food security is a fundamental aspect of sustainable human development. It fuses the goals of household food security and sustainable agriculture. A commitment to sustainable food security requires addressing not only increasing agricultural production but also income and land distribution, dietary needs, women's status and opportunities, and the protection and regeneration of the resource base for food production (Dowling et al., 1998).

The word sustainability has become a *buzz* word over the decades. Apart from the potential difficulties encountered in finding data to determine which production practices are sustainable, there is an absence of agreement on the appropriate definition of sustainability (Herdt and Steiner, 1995). Conway (1987) for example, defines sustainability as the ability of an agro-ecosystem to maintain productivity when subject to a major disturbing force. This represents the resilience of the system. The Bruntland commission defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987).

Apart from the United States Department of Agriculture (USDA) definition, another dimension of sustainable agriculture is added by scholars who propose that '. . . sustainable agriculture is not just a set of practices but a process requiring skills of adaptability' (Wall and Smit, 2005). Altieri (1989), on the other hand, defines sustainable agriculture as a system which should aim to maintain production in the long-run without degrading the resources base, by using low input technologies that improve soil fertility, by maximizing recycling, enhancing biological pest control, diversifying production, and so on. According to Jacobsen (2012), a key to successful sustainable production is healthy soil, with a central tenet that management practices "feed the soil and the soil feeds the crop." Ecologically, this means that soil fertility is provided by adequate soil organic matter and biologically based inputs that feed soil organisms, which release nutrients to plants. Sustainable methods of enhancing soil fertility and improving soil health include: using nitrogen-fixing legumes, green manure, and animal manure; minimizing or eliminating tillage; and maintaining year round soil cover. Residual management and conservation tillage are other sustainable practices where the amount, orientation, and distribution of crop and plant residue on the soil surface are managed and such practices improve the ability of the soil to hold moisture, reduces water run-off from the field, and reduces surface evaporation (De Guzman and Zamora, 2012). Small farmers should consider the use of low cost technologies but capable of enhancing rice yield which include making of mulches from crop residues, preparing compost from manure or recycled waste, green manure, biofertilizers, soil and water harvesting, bio-pesticides and agro-forestry (Abas, 2014).

In the Mediterranean, Chartzoulakis and Bertaki (2015) posit that adoption of SAPs , in particular, sustainable water management is not only a technological problem but involves many other considerations relative to social behavior of rural communities, the economic constrains, or the legal and institutional framework that may favor the adoption of some measures and not others.

Teklewold et al., (2013) in a study in rural Ethiopia on adoption of multiple SAPs found that the probability and extent of adoption of SAPs are influenced by several factors namely: social capital in the form of membership of rural institutions, credit constraint, spouse education, asset ownership, distance to markets, mode of transportation, rainfall and plot-level disturbances, the number of relatives and traders known by the farmer inside and outside his village, farmer's belief in government support during crop failure and confidence in the skill of extension agents.

In Vietnam, banana farrmers' rate of adoption of SAPs was high for practices related to harvest and post harvest, indigenous knowledge use, cattle management in fields, crop rotation and weed control; whereas, the practices adopted in low rate or not adopted were related to input uses (soil, water, chemicals and seedling), quality management of products, linkage in consumption, production cooperation and product label establishment. In the same vein, five factors had a significant influence on farmers' SAPs adoption, namely sustainable agricultural perception, economic status, extension courses, education and feasibility of practices. Sustainable agricultural perception had the most influence on the adoption of SAPs (Van Thanh and Yapwattanaphun, 2015). Mwea Irrigation scheme is the largest in Kenya for rice production but yields have been declining over the years. One of the factors to sustained production is adopting sustainable agricultural practices. The objective of this research was to determine the influence of farmers' socioeconomic characteristics

on application of sustainable agriculture practices (SAPs) in rice farming in Mwea and the challenges the farmers face in applying SAPs.

METHODOLOGY

This study adopted the cross sectional survey design. Data was collected in January 2014 using a questionnaire as the main instrument. The target population in this study consisted of the 3242 rice farming households in Mwea (00° 42' 00" S, 37° 22' 00" E) in Kirinyaga County. Mwea is about 100 Km North East of Nairobi. Farmers in Mwea irrigation scheme predominantly produce rice since its inception in 1956. Farmers, partially or wholly dependent on rice cultivation to earn their livelihoods were sampled for this study. The household head was selected as the respondent. Stratified sampling was done. Mwea scheme is divided into five (5) sections, (Tebere, Nguka, Wamumu, Karaba and Thiba), these were included in the study to form the strata. Sample size was determined using the formula (Amin, 2005);

$$n = \frac{Z^2.p.q.N}{e^2(N-1)+Z^2.p.q}$$

Where;
n= Sample size
Z= Std Variate at a given confidence limit (1.96 at 95%)
p= Sample proportion = 0.05
q= (1-p) =0.95
N= Size of population=3242
e= Maximum error=0.05

$$n = \frac{1.962\times0.05\times0.95\times3242}{(0.05)^2\,(3242-1) + 1.96^2\times0.05\times0.98} = 144$$

To sample proportionately from each section (Amin, 2005), the following calculation was made and results shown in Table 1:

$$\frac{\text{No. of farm families in the section}}{\text{Total No. of farm families in Mwea}} \times 144$$

RESULTS AND DISCUSSION

Description of the Socioeconomic Characteristics of the Farmers

Results of the socioeconomic characteristics of the rice farmers in Mwea are shown in Table 2. The study revealed that a greater percentage of the respondents' were males. Rice is grown mainly as a cash crop by the farmers in Mwea. This finding support Njuki et al., (2012) observations that cash crops are often found to be male-dominated. This implies that fewer women are directly involved in the production of rice as an activity in the rice value chain. Majority of the respondents had at least primary education (72.2%). However close to 30% had less than primary education and only 18.8% had above secondary education. The mean age was 42 with a standard deviation of 8.82. Also, 29.7% of the respondents were below the age of 35 years. This implies that most of the farmers are still youthful to undertake farming activities and indicate the growing interest of the youth in farming. This is contrary to Ajah (2012) study in Nigeria that revealed that only 7% of farmers were in their youthful ages showing a disinterest in farming. In terms of years of experience, many farmers were experienced in rice growing (Mean 9.73 years) with a standard deviation of 8.377 which shows a considerable variability in the experience of respondents.

For the farm size being cultivated by the respondents, results of this study revealed that a majority of the respondents cultivated between 0.5 - 5 acreage of land (95%). The average land size under rice cultivation for the respondents was 2.4 acres and standard deviation of 1.93 with the minimum land size of 0.5 acres and 12 acres as the maximum. This implies that small scale production of rice is predominant in Mwea. Small scale farming is practiced extensively in other parts of Africa and is not confined to rice but also to other crops. Results of a survey undertaken by IITA (2005) in Nigeria and a FAO (2012) report on Ghana assert that small scale cassava producers cultivating less than 2ha (5acres) constitute about 95%, while those cultivating over 5ha constitute about 5%. There is need to create incentives that can enable a small scale farmer to improve and increase productivity.

Relationship Between Extent of Application of SAPS in Mwea and Farmers Socioeconomic Characteristics

A correlation test was done and it showed that there was positive and significant relationship between extent of application of SAPs by farmers and their level of knowledge (r=0.739), educational attainment,

Table 1. Sample Size Selected From Each Section of the Study Area.

Section	Tebere	Nguka	Thiba	Wamumu	Karaba	Total
No. Farm families	707	672	653	626	584	3242
Sample size	30	30	28	28	28	144

Source : Field data, 2014.

(r=0.490), size of land under rice (r=0.243 membership to an organization (r=0.443) and contact with extension (r=0.395). No significant relationship existed between extent of application of SAPs and age, sex, household size, alternative livelihood, experience and source of credit. This result agrees with that of Akudugu et al., (2012) who too found educational level and exposure to information through extension to have a positive and significant relationship with adoption of innovations and concluded that education creates the right mental attitude for the acceptance of new practices, especially information intensive and management intensive practices.

Predictors of Level of Application of SAPs among Rice Farmers

Socioeconomic characteristics of the farmers and the application of the individual SAPs were used to determine the best predictor(s) of extent of application of SAPs by the farmers because they had significant relationship. A collinearity diagnostic test was conducted on the variables that were significantly correlated to the dependent variable to find out if any of the explanatory variables were strongly related to the dependent variable. The test showed that there was no significant collinearity among the independent variables.

A multiple linear regression was run using extent of application of SAPs as the dependent variable. Five (5) variables entered the model and explained 47.7% of the variance in extent of application. Three (3) of the variables were significant and these were knowledge, membership to an organisation and contact with extension. Level of knowledge had an impact of 0.631, membership to an organization had an impact of 0.835 and contact with extension had an impact of 0.148 on the dependent variable. The regression equation is summarised below:

$Y= \beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\varepsilon$

Where;

Y= Extent of application of SAPs
β=constant
X_1= Knowledge on SAPs
X_2= Membership to an organization
X_3=Contact with extension

Y = -0.094+ 0.631(knowledge) + 0.835(membership to an organization) + 0.148(contact with extension) + 1.22

The implication is that for a farmer to apply a certain SAP he must be aware of it first. The higher the level of knowledge the more likely the farmer is to apply it. Membership to an organization is a proxy for social capital. Social capital has an implication on the networks the farmer has. The stronger the networks the more likely the farmer has the chance to see innovations from among his/her networks. In the diffusion of innovations theory Rogers (2003) posits that the easier it is for individuals to see the results of an innovation, the more likely they are to adopt it. Such visibility stimulates peer discussion of a new idea, as friends and neighbours of an adopter often request innovation-evaluation information about it. These findings agree with the assertions of Fazio et al., (2006) that participation in groups helps farmers vocalize their needs and further their awareness and knowledge concerning sustainable practices. Sharing of experiences could empower farmers to make decisions about sustainable agriculture and to adopt new sustainable practices. Hassanein and Kloppenburg (1995) noted that the type of socialization encouraged in grassroot groups is important for a transition to sustainable agriculture, since in these groups farmers are able to identify and share knowledge with other farmers who are in similar farming situations. Instead of relying on traditional sources of information, farmers produce and share knowledge themselves which is an important catalyst for change, since although sustainable agriculture information can be gained elsewhere; insights into the practice of sustainable agriculture are gained from the locale-specific experiences of other local farmers. Contact with

Table 2. Rice Farmers' Characteristics in Mwea.

Characteristic	Frequency	Percentage	Mean	SD
Sex				
Male	89	62.1	-	-
Female	55	37.9		
Age (Years)				
20 – 29	7	5.0	42	8.82
30 – 39	61	43.6		
40 – 49	37	26.4		
50 – 59	34	24.3		
60 and above	1	0.7		
Years of schooling				
0-6	40	27.8		
7-11	77	53.4		
12 and above	27	18.8		
Characteristic	**Frequency**	**Percentage**	**Mean**	**SD**
1-4	84	59.2		
5-8	53	37.3		
9 and above	5	3.5		
Size of land under rice cultivation (acres)				
0.5 – 2.5	104	73.8	2.43	1.93
3.0 - 5.0	30	21.3		
5.5 – 7.0	4	2.8		
7.5 – 9.0	2	1.4		
9.5 and above	1	0.7		
Ownership status of land under rice cultivation				
Own	94	65.3	-	-
Lease	7	4.9		
Rented	43	29.9		
Farming Experience (years)				
1-9	58	50.4	9.73	8.38
10-19	28	24.3		
20-29	10	8.7		
30-39	7	6.1		
40-49	1	0.9		
50 and above	11	9.6		

Source: Field data, 2014.

extension implies an interaction with a change agent.

In adopting SAPs, this is important because at every stage the farmer seeks information to be able to make informed decisions. Extension serves as the link between the researchers in institutions and

Table 3. Major Challenges Hindering Adoption of Sustainable Agriculture Practices among Rice Farmers in Mwea.

Constraint	Frequency	Percent
Pests and Diseases	103	72
Lack of capital	81	56
Poor markets and lack of premium prices	76	53
Climatic changes leading to shortage of water	71	49
Lack of information	66	46
Social vices such as theft	60	42

n= 144 (*Multiple responses); Source: Field data, 2014.

the farmer. In this study few farmers had contact with extension.

Challenges Hindering Rice Farmers from Adopting Sustainable Agriculture Practices

When the rice farmers were asked to name the challenges they faced in adopting SAPs, several challenges were found to be important to the rice farmers as shown in Table 3. From the results, pests and diseases of rice especially birds and rice blast was cited as the main constraint that was hindering the farmers from adopting SAPs. Rice blast, caused by a fungus causes lesions to form on leaves, stems, peduncles, panicles, seeds and even roots. Rice blast is often severe in fields that were not rotated, are under irrigated and are over fertilized (TeBeest et al., 2007). This is one reason why the farmers should apply SAPs but on the contrary it is the top most reason why they cannot apply SAPs. This clearly shows an information gap regarding SAPs. The farmers were risk aversive by maintaining the control strategies they have been using. This result agrees with Yengoh et al., (2009) assertion that farmers who are more vulnerable to risk will prefer taking less risk and tend to be late adopters.

Respondents who cited lack of capital as a constraint to adopting SAPs argued that for example a 90kg bag of organic manure was costly, retailing at not less than 200 Kshs (approximately 2.2USD at the time of study). The positive effect of organic manure on the farm is long term but the farmers need quick response provided by inorganic fertilizers despite the realization that production is not stable. Other inputs that require capital include certified seeds, labour, processing and storage. Poor markets and lack of premium prices for sustainably grown rice was the third main constraint among rice farmers in Mwea. The main actors in the rice value chain in Kenya consist of input and service providers, primary producers, logistics centers and industries, traders and final consumers. The respondents in this study were the primary producers consisting of tenant farmers/leaseholders and owner cultivators. The farmers complained of being exploited by brokers and so they were not motivated to produce rice any differently from their current practices. The farmers further were aware of existence of premium prices for horticulture produce especially vegetables and fruits grown organically but argued that they were not aware of such prices for rice. Price therefore plays a key motivation role in a farmer's decision of how to produce.

The fourth constraint cited by respondents was unpredicted weather changes that were leading to shortage of water. Mwea rice farmers grow paddy rice on flooded fields. This requires that there is plenty of water at planting stage. Agriculture is itself responsible for an estimated one third of climate change. It is generally agreed that about 25% of carbon dioxide emissions are produced by agricultural sources mainly deforestation, the use of fossil fuel based fertilizers and the burning of biomass. Most of the methane in the atmosphere comes from domestic ruminants, forest fires, wetland rice cultivation and waste products, while conventional tillage and fertilizer use account for 70% of the nitrous oxides (Smith et al., 2007).

Lack of agricultural information was the other main challenge farmers faced in Mwea. 46% of the respondents attributed their failure to adopt SAPs to lack of information. They had little or no idea at all about some of the SAPs. In Kenya, agriculture

information is disseminated to farmers either through public extension services or through private extension services. With the passing of the new constitution agriculture is one of those sectors that has been completely devolved to the counties and hence it's a challenge to county governments to develop a strong team of extension agents to meet the needs of farmers.

Social vices such as stealing also hindered the farmers to apply SAPs. Theft was mentioned by 60 out of the 144 respondents as being a main constraint in applying SAPs on their rice fields especially the practice of retaining crop residues on farmers' fields. This translates to 42% of the total number of respondents. The residues are sold to livestock keepers and hence generate some additional income to the farmer. However, if left on farmer's field, incidences of theft are common and discouraging to the farmer.

CONCLUSION

Youth in Mwea have an interest in rice farming. The sector is dominated by males. Farmer's knowledge regarding SAPs, membership to an organisation and contact with extension are important determinants of applying SAPs among rice farmers in Mwea. Adoption of SAPs in rice farming is hindered by many challenges key among them being pest and disease control, lack of capital and poor marketing strategies.

RECOMMENDATION

The extension services in the county should be revamped to strengthen the farmer's capacity to innovate by providing access to knowledge and information. Also since extension agents are active players of the demonstration or adoption process, they can be a great motivator for farmers to adopt sustainable agriculture practices.

A trade policy to ensure that farmers in producer groups who grow rice using sustainable agriculture practices receive premium prices should be formulated. A policy to encourage the youth to be interested in agriculture should be formulated at the county level. The county government of Kirinyaga should address the challenges cited by farmers as hindering them to adopt SAPs in rice farming.

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